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Abstract

DEVELOPMENT OF CERAMIC NUCLEAR MATERIALS IN THE CZECHOSLOVAK SOCIALIST REPUBLIC

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The development of ceramic nuclear materials in the Czechoslovak Socialist Republic started with a concept of the DOR reactor. Uranium dioxide powder was studied as a raw material for the preparation of dense ceramic fuel. Besides, attention was paid to the densification by means of standard powder-metallurgy techniques and to the relations between physico-dispersion properties of the powder and its behaviour during fabrication.

All basic stages of UO_2 powder preparation were studied in detail beginning with ADU precipitation, drying, heat treatment to give UO_3 or U_3O_8, and also reduction to UO_2. A correlation between the powdery product properties and a number of factors affecting the preparation was found. The relations between aggregate structure, specific surface area, and chemical reactivity found out during these research works enable easy control of a technological preparation process and correction of inconvenient properties.

UO_2 powder samples with specific surface areas ranging from about 2.5 to about 13 sq.m/g were compacted by cold-pressing. It was found that the compactability of UO_2 powder can be described mathematically. On the basis of coherence between the fine structure and the compactability of the powder, the density after pressing or the pressure needed to reach a definite density can be estimated. Sintering of the compacts was studied especially in reduction atmosphere of hydrogen in the temperature range from 1200° to 1800° and its sintering properties were also found for this process. On the basis of physico-chemical measurements resulting density value accurate within 1% can be estimated and optimum pressing and sintering conditions determined at the same time.

Several theoretical questions concerning ADU structure changes during precipitation and the post-reduction non-stoichiometric oxygen location in UO_2 structure were also investigated.

Preparation methods of non-pyrophoric uranium powder with well controllable grain size were worked out for the synthesis of other types of ceramic fuels. A process of UO_2-SiO_2 co-reduction with calcium hydride was investigated. Grain growth of the metal phase during heat exposure was measured in a U ÷ UC cermet system.